EIS001521

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FEB 15 2000

February 7, 2000

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U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 30307
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Dear Ms. Dixon:

Thank you for the opportunity to review and comment on the U.S. Department of Energy's (DOE) *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada.* Following are comments on, questions about, and suggested revisions to the Summary, Volume I - Impact Analyses Chapters 1 through 15, and Volume II - Appendixes A through L of the Draft Environmental Impact Statement (DEIS); followed by some generalized statements and recommendations.

Summary:

1 **1. Page S-14, S.3.1.2 Performance Confirmation. Construction, Operation and Monitoring, and Closure, second paragraph**--(*Performance confirmation*) The statement, "...activities would continue until after the closure of the repository," is confusing. It sounds as if the activity will stop at some point in time. Simply say the activities will continue "following" the closure.

2 **2. Page S-17, Figure S-7**--Label East Main, Exhaust Main and West Main as Drifts for clarity; and show the actual location of the north portal, as is done for the south portal.

3 **3. Page S-33, first paragraph**--Devils Hole appears to be "east" of Ash Meadows, not "south" as so stated (see page S-34, Figure S-17).

4 **4. Page S-33, second paragraph**--Lathrop Wells is not on page S-34, Figure S-17, nor should it be, as the community name no longer exists. During the late 1980's the community name was

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changed from Lathrop Wells to Amargosa Valley, which is shown on page S-34, Figure S-17. Lathrop Wells should not be referred to here or elsewhere in the DEIS.

5 5. **Page S-34, Figure S-17**--The southwest to northeast trending stippled property, located southeast of Indian Springs, is not identified in the Legend.

6 6. **Page S-37, S.4.1.4 Hydrology, first paragraph**--Ground water is two words, as are surface water, stream water, spring water, perched water, and rain water, etc. Also, define saturated zone versus aquifer (as defined in the "GROUND WATER" blockout on page S-39).

7 7. **Page S-39, sixth paragraph**--(*Ground Water*) By definition, confining units "do not" allow considerable (ground-water) movement between aquifers. If they do, they are not confining units. The term "aquitards" should be used when and where ground water moves through lowly-permeable units.

8 8. **Page S-39, seventh paragraph, and page S-41, first paragraph**--The Amargosa Desert is not shown on page S-40, Figure S-19. Also, the relationship between the Death Valley ground-water basin, the Central Death Valley Subregion, and the three sub-basins should be clarified. Is it the Alkali Flat-Furnace Creek "Ranch" ground-water sub-basin or the Alkali Flat-Furnace Creek ground-water sub-basin (page S-40, Figure S-19)?

9 9. **Page S-40, Figure S-19**--(Legend) "Subregion boundary" should be labeled as the "Central Death Valley Subregion boundary" and the subregion should be defined in the text; "Ground-water basins and sections" should be labeled "Ground-water sub-basins and sections" and defined hydrogeologically in the text; Pahute Mesa-Oasis Valley Ground-Water Basin should be designated as a sub-basin (as well as the other two sub-basins); and Jackass Flats appears to be part of the Specter Range section and not part of the Fortymile Canyon section. What is a ground-water section? The term is not defined in the Summary text, or anywhere else in the DEIS for that matter. Do sections equate to the State of Nevada's hydrographic areas? According to the referral to the Jackass Flats area (page S-41, fifth paragraph), they do not equate.

10 10. **Page S-41, second paragraph**--Again, the three ground-water sub-basins are not part of the Death Valley ground-water basin but are divisions of a subset of that basin, the Central Death Valley ground-water subregion.

11 11. **Page S-41, fifth paragraph**--The term "perennial yield" is confusing. Perennial usually refers to surface water (stream) conditions and indicates that water is flowing along the stream course on a continuing basis, but it has no connotation in terms of base-flow quantities and/or volumetric measurements. Ground-water hydrologists usually use the term "safe yield" (which no one really likes or has adequately defined) or the term "optimal yield" (defined by set of socio-economic objectives associated with ultimate water use). In either case, the concern is to prevent overdraft of an aquifer (water being discharged from an aquifer is greater than recharge water coming into it), but to use a term that supposedly relates to overdraft concerns, and that here-to-fore has not been used in the hydrological sciences causes confusion (an element of the DEIS that should be eradicated, or at least, limited).

12 **12. Page S-52, S.4.2 TRANSPORTATION, first paragraph**--Reference to Figures 13 and 14 should be to Figures S-13 and S-14.

13 **13. Page S-66, Table S-1**--Water demand values listed under Hydrology (ground water and surface water), of 250 to 480 acre-feet per year, are not the same as those listed for the Jackass Flats hydrographic area on page 3-40, Table 3-11, footnote f, of Volume I (300 acre-feet for the eastern third of the area and 580 acre-feet for the western two-thirds). Where did the 250 to 480 acre-feet values come from? Revise for consistency.

Volume I - Impact Analyses Chapters 1 through 15:

14 **1. Page 1-16, Figure 1-6**--This figure should appear in the Summary on or near pages S-32 and S-33, in S.4.1 YUCCA MOUNTAIN SITE AND VICINITY, for reader clarification in understanding the size and extent of the land-withdrawal area.

15 **2. Page 2-15, Figure 2-9, and Page 4-2, Figure 4-1**--These two identical milestone figures do not correlate well (or they don't appear to) with page S-19, Figure S-9 (showing expected sequencing) in the Summary. As examples, Figures 2-9 and 4-1 show construction beginning in 2005 whereas Figure S-9 shows NRC construction authorization sometime between 2005 and 2010; Figures 2-9 and 4-1 show waste emplacement completion during 2033 and it appears on Figure S-9 that emplacement operations would end sometime between 2033 and 2110; and Figures 2-9 and 4-1 indicate that repository closure would be sometime between 2116 and 2125, but Figure S-9 seems to show that closure would be during 2125 (since that year is bracketed). These time schedules should be easily interpretable and relate from one to another, they are important!

16 **3. Page 2-26, Figure 2-16**--The low-thermal-load (l-t-l) expansion is not detailed in the text or figures in the Summary, pages S-14 through S-21. It is mentioned in the "THERMAL LOAD" blockout, page S-14, that l-t-l conditions would cause an increase in the subsurface area and excavation of the repository, but the fact that the l-t-l build-out would more than double the size of the repository design is not mentioned. This expansion would encounter a greater number of faults, perhaps differing hydrogeologic conditions, and create additional radiological hazard scenarios, etc. These are very important l-t-l factors that deserve much more attention in the Summary.

17 **4. Page 3-6, Figure 3-1**--Following this page, the Chapter 2 pages 2-65 through 2-88 are repeated; followed by a repeat of Chapter 3 pages 3-1 through 3-6; and pagination resumes with page 3-39. Therefore, Chapter 3 pages 3-7 through 3-38 (containing much of the geologic and hydrologic information in the Affected Environment chapter) were missing from the copy of the DEIS that I received. Hopefully this was not the case for too many copies of the DEIS that were mailed out. The missing pages were copied from the DEIS www-site, and hopefully others had access to this site.

18 5. **Page 3-8, Figure 3-2**--Yucca Mountain is located too far north on the figure. Move the symbol about five miles south to coincide with the location on page 1-16, Figure 1-6, and page 3-6, Figure 3-1.

19 6. **Page 3-12, 3.1.2.2 Climate, first paragraph**--Have these extreme precipitation events been used in determining Yucca Mountain infiltration (recharge) rates as discussed later in this chapter? Applying a range of locality-based infiltration rates would be much more realistic than using a whole-mountain average.

20 7. **Page 3-17, Figure 3-5**--(Legend) No ages for the "Caldera volcanic center" and "Other bedrock" units are given, while the others show approximate ranges. Consistency is needed. Also, Qby, Qbo, Typ, and Tyb are not defined here or in the text. Do these units relate to page 3-19, Table 3-6, or page 3-20, Table 3-7?

21 8. **Page 3-22, Figure 3-7**--There are many more than the three or four "major" faults shown on this figure (see page 3-23, Figure 3-8, and page 3-27, Figure 3-10), and as such, the figure presents a very unrealistic presentation of the faulting in the repository area.

22 9. **Page 3-23, Figure 3-8**--The geology and faulting presented on this cross-section does not correlate well with the B-B' trace on page 3-22, Figure 3-7. The cross-section should be simplified to accurately represent the trace as shown on the generalized bedrock geology map.

23 10. **Page 3-29, 3.1.3.3 MODERN SEISMIC ACTIVITY, first paragraph**--References are needed for all the assertions made in this paragraph. For instance, it is not common knowledge that regional earthquake epicenters do not correlate with Quaternary faults in the Yucca Mountain area (a figure would also be nice).

24 11. **Page 3-29, 3.1.3.3 MODERN SEISMIC ACTIVITY, fourth paragraph**--Did the Probabilistic Seismic Hazard Analysis produce a hazard map? If so, including it as a figure would greatly clarify this discussion. Also, an example of a hazard curve showing ground motion/fault displacement/annual frequency relationships would be helpful.

25 12. **Page 3-30, first paragraph**--In this paragraph, fault displacements are related to the layout design of the central block of the repository. It does not appear that the same consideration was given to the design of the l-t-l expansion blocks (especially the westward extension). If it was, it should be mentioned in the text.

26 13. **Page 3-31, 3.1.4.1 Surface Water, 3.1.4.1.1 Regional Surface Drainage, first paragraph**--The term "permanent streams" should be changed to "perennial streams" for consistency with other DEIS sections. Also, the referred locations, Tecopa, Peterson Reservoir, Lower Crystal Marsh, Horseshoe Reservoir, and Ash Meadows, are not shown on page 3-32, Figure 3-11, as they should be.

27 14. **Page 3-32, Figure 3-11**--The surface drainage areas shown on the figure are not discussed in the text. Why are they important? How do they relate to each other and what is their

significance to this DEIS? Were they separated by hydrologic unit characteristics? In other words, why is this figure presented?

28 **15. Page 3-33, 3.1.4.2 Yucca Mountain Surface Drainage, first paragraph--**(*Occurrence*) Is Fortymile Wash the same as Fortymile Canyon on page 3-34, Figure 3-12 (and other figures in this volume)? Use consistent terminology.

29 **16. Page 3-33, 3.1.4.2 Yucca Mountain Surface Drainage, second paragraph--**(*Flood Potential)* Why is a "regional maximum flood" important when repository facilities are designed for a "probable maximum flood" (pmf)? Also, the definition of a regional maximum flood in the "PREDICTED FLOODS" blockout presents no relationship to time, or recurrence intervals, or flow volumes. Why include this term or does it have an analytical use?

30 **17. Page 3-35, Table 3-9--**No reference is given for regional maximum flood numbers, and why show these numbers anyway? Repository design is for a pmf event.

31 **18. Page 3-35, second paragraph--**"In no case" is a rather strong statement when the estimated area of inundation for a pmf event may come within about 300 feet of the north portal (see page 3-34, Figure 3-12). The ranges for error of estimation of volumetric estimates for a pmf event need to be very small in order to support this statement. Are they? These ranges should be included with the data.

32 **19. Page 3-36, 3.1.4.2.1 Regional Ground Water, first paragraph--**Concerning the "confining unit" statement, see Summary, comment number 7 in this review.

33 **20. Page 3-37, second paragraph--**(*Basins*) In discussing regional geographic features, a reference to page 3-38, Figure 3-13 should be made (or to another figure that shows the entire Death Valley region). Also, recharge and discharge points would be much easier to visualize with a figure. According to page 3-38, Figure 3-13, ground-water flow is primarily to the south; the only western flow-direction arrow shown is questioned.

34 **21. Page 3-37, third paragraph--**All of the comments listed in the Summary items numbered 8, 9, and 10 in this review are pertinent to this paragraph and page 3-38, Figure 3-13. Also, were ground-water levels measured in wells that were completed in the same aquifer? If not, this would make the potentiometric-surface map useless (a figure showing this surface would also help). Statement about "other data" should be referenced. Mention in the discussion that flow in the aquifer(s) below Yucca Mountain is addressing primarily the water-table aquifer. Likewise, discharge areas relevant to the aquifer(s) underlying Yucca Mountain are also in reference to the water-table aquifer, or are they? Clarification is needed.

35 **22. Page 3-37, fourth paragraph--**Is outflow from the Ash Meadows ground-water sub-basin, in part, to a lower portion of the Alkali Flat-Furnace Creek Ranch ground-water sub-basin? Is the latter basin composed of upper and lower aquifer units, or is this merely referring to an entry point and the incoming ground water becomes homogenized volumetrically in the Alkali Flats-Furnace Creek Ranch water-table aquifer? Again, a potentiometric-surface map would greatly facilitate the visualization of these concepts. Also, Ash Meadows is the primary discharge

point for which sub-basin? Are the springs at Ash Meadows a discharge point for the water-table aquifer (for which the sub-basin designations have been defined), or for a deeper confined aquifer (the lower carbonate aquifer on page 3-45, Figure 3-15)? A reference is needed for the statement "…springs occur in a line along a major fault."

36 **23. Page 3-37, fifth paragraph**--Pahute Mesa-Oasis Valley ground-water sub-basin includes "all" of Gold Flat and Oasis Valley; southern part of Cactus Flat; and southern part of Kawich Valley (designated a ground-water section, so it must be important). See page 3-38, Figure 3-13, for name locations.

37 **24. Page 3-38, Figure 3-13**--The Amargosa Desert is not shown on this figure. Again, is it Alkali Flats-Furnace Creek ground-water sub-basin or Alkali Flats-Furnace Creek "Ranch" ground-water sub-basin? (see Summary, comment number 8 in this review)

38 **25. Page 3-39, second paragraph**--According to page 3-38, Figure 3-13, Fortymile Canyon lies within the Alkali Flats-Furnace Creek Ranch ground-water sub-basin, yet it is not mentioned here. This is a very important hydrogeologic feature and should be emphasized.

39 **26. Page 3-39, third paragraph**--Reference the "one numerical model for infiltration" statement and justify the use of an average rate versus analyzing end members of a range of values. Also, the "in comparison" sentence should provide referenced values, or there is nothing to compare.

40 **27. Page 3-39, fourth paragraph**--Define "hydrographic areas." They are not shown on page 3-38, Figure 3-13, and not discussed as hydrologic features.

41 **28. Page 3-39, fifth paragraph**--The "line of springs" location should be shown on page 3-38, Figure 3-13, for clarity. Also, referring to discharge points, a potentiometric-surface map and hydrochemical data as evidence for the springs' locations, while not presenting that evidence, is insufficient. Include the map and examples of the data for clarity and justification of the statement.

42 **29. Page 3-39, sixth paragraph**--Again, the "Central Death Valley" designation is for a ground-water sub-region, not a ground-water basin.

43 **30. Page 3-40, first paragraph**--Again, if hydrographic areas are finer divisions of basins and/or sub-basins, define them hydrologically. Also, the hydrographic areas are not consistent with locations shown on page 3-38, Figure 3-13, because they are not even shown on the figure. Reference water-use withdrawal amounts listed throughout the paragraph. Define Devil's Hole, and why it is important.

44 **31. Page 3-49, Table 3-11**--The low end of the Jackass Flats hydrographic area "perennial" yield estimate is 880 acre-feet per year; yet on page S-41, section S.4.1.4 Hydrology, of the Summary, fifth paragraph, that number is given as 890 acre-feet—which is correct?

45 **32. Page 3-41, first paragraph**--The comment about the usage of acre-feet should have come earlier in the chapter as it has already been used several times (on page 3-37, for example).

46 **33. Page 3-41, second paragraph**--(*Ground-Water Quality*) Programs that sample ground water for water-quality purposes are mentioned but no generalized information about the results are listed. Even though more detailed results concerning the subject are given in subsequent sections of Chapter 3 for the Yucca Mountain area, because this discussion is about regional hydological aspects, generalized water-quality descriptions of the ground-water sub-basins should be listed, if available.

47 **34. Page 3-41, 3.1.4.2.2 Ground Water at Yucca Mountain; Unsaturated Zone, first paragraph**--(*Water Occurrence*) Given that the perched-water bodies contain young water, as compared to pore-space water, and the attitude of the geologic units is dipping downward into a fault plane, could it be that the perched water exists merely by the fact that faulting off-set of a somewhat incompetent unit (like the Calico Hills nonwelded unit) creates a lowly-permeable fault "gouge" (or fill) that prevents further movement of water down that fault plane? In time, the Calico Hills nonwelded unit underlying the perched-water body will become saturated and drain off the perched water down-dip towards the fault plane (unless there is substantial and constant source of recharge to sustain the perched-water body). Therefore, the presence of the perched water indicates that there may be significant amount of lowly-permeable fault gouge associated with this faulted system. Perhaps too much importance is being placed on the perching unit (layer).

48 **35. Page 3-42**--(*Hydrologic Properties of Rock*, second paragraph) What is an igneous versus volcanic flow? Is this referring to an igneous-intrusive sill? Or should the discussion center on the differences between ash-fall versus ash-flow tuffs? Volcanic flows may be silicic to basaltic (or anything in between) in mineralogical composition, but igneous is not a correct descriptor.

49 **36. Page 3-44, Table 3-12**--Provide permeability information for all described hydrogeologic units to coincide with hydrologic discussion on previous pages. Also, only effective-porosity values are meaningful in determining water movement through sub-surface units--are these effective-porosity estimates? If not, they should be replaced with the appropriate estimates. The description of the Calico Hills nonwelded unit should include the basal vitrophyre and nonwelded tuffs of the Topopah Spring Tuff (as shown on page 3-45, Figure 3-15). This is important because later discussions (page 3-47, third paragraph) suggest that the basal vitrophyre and nonwelded tuffs of the Topopah Spring Tuff may or may not be the perching layer.

50 **37. Page 3-44, second paragraph**--(*Water Source and Movement*) Range values should be used as well as the average (see Volume I, comment number 6 in this review). Using the high-end of the infiltration range of 3 inches per year would have an order of magnitude difference (when considering the resultant consequences on the stability of waste in the repository) as compared to an average of 0.3 inch. Water volumes would be much greater, and the amount of time to reach a relevant sub-surface horizon much less.

51 **38. Page 3-45, Figure 3-15**--There is no mention of the areal extent of the hydrogeologic unit QTc, valley-fill confining unit. Does it underlie QTa, valley-fill aquifer, in many, most, or all places? Also, "uva, Upper volcanic" should have "aquifer" added to the name.

52 **39. Page 3-46, first and second paragraphs**--The discussion of water movement through the unsaturated zone via fault-plane pathways is the over-riding reason for including the high-end range value for infiltration, and the possible movement of water to and through a proposed repository block (see Volume I, comment number 36 in this review). Yucca Mountain is resident to many prominent faults (especially for the expanded area of the l-t-l build-out blocks), and an assessment of the Mountain's appropriateness for use as a viable site for radioactive-waste disposal must include a probable high-end analysis.

53 **40. Page 3-47, second paragraph, third bullet**--Explain why the 10-foot soil depth over a fracture is important. If the soil horizon is already saturated prior to a precipitation event, the residence time of infiltrating water in that soil horizon may be minimal before a fault plane is encountered. In addition, a 10-foot thick soil in this environment would be somewhat unusual; or are we discussing alluvial, colluvial, or other surficial deposits here?

54 **41. Page 3-47, third paragraph**--The statement, "...low-permeability zeolite zones impede the vertical flow of water near (the base of) the Topopah Spring welded unit and its contact with the underlying Calico Hills nonwelded unit, forming perched-water bodies," suggests that the perching-zeolitic zone is within the basal part of the Topopah Spring welded unit, and not the basal vitrophyre and nonwelded tuffs of the Topopah Spring Tuff (which is the upper part of the Calico Hills nonwelded hydrogeologic unit, see page 3-45, Figure 3-15). Please clarify the sub-surface location of the perching unit. Also, after clarification, this statement should come earlier in Chapter 3 where perched-water bodies are first mentioned (see the Unsaturated Zone, *Water Occurrence* discussion on pages 3-41 and 3-42).

55 **42. Page 3-48, Table 3-13**--From which hydrogeologic unit was the analyzed pore water collected? This water-quality comparison is meaningful for only those units near and connected with the perched-water bodies. Was pore water collected from the Calico Hills nonwelded unit, beneath a perched-water body (if doable)? This would help determine if the perched water is moving down through the unit and "down dip" towards the fault plane where a higher degree of remobilization may occur (see Volume I, comment number 34 in this review).

56 **43. Page 3-48, Saturated Zone, first paragraph**--(*Water Occurrence*) Again, the upper confining unit description does not include the basal vitrophyre and nonwelded tuffs of the Topopah Spring Tuff (see page 3-45, Figure 3-15). Also, why change the names of the hydrologic units as they are listed for the Yucca Mountain vicinity on page 3-45, Figure 3-15, when discussing the hydrogeologic sequence immediately below the Mountain (middle volcanic aquifer on the figure is referred to as the lower volcanic aquifer in the text)? This causes confusion and is incorrect nomenclature when looking at the hydrogeology of the Yucca Mountain vicinity/area.

57 **44. Page 3-48, Saturated Zone, second paragraph**--"Down stream" is a surface-water term, and is not used for discussing ground-water movement. Down gradient is appropriate. Also, there

are many flowpaths beneath Yucca Mountain, not one, as the discussion seems to indicate. Relate the first sentence of this paragraph to page 3-38, Figure 3-13, for clarity.

58 **45. Page 3-48, Saturated Zone, third paragraph**--"Evidence" for water ages should be given, or at least an example, with statements and values referenced. In fact, nearly every sentence in this paragraph (continued at the top of page 3-49) requires a reference. "Limited data" do not show anything unless they are shown. And referenced.

59 **46. Page 3-49, first paragraph**--(top of page) The statement, "This indicates that, in the vicinity of Yucca Mountain, water from the lower carbonate aquifer is pushing up against a confining layer with more force than the water in the upper aquifers is pushing down" which defines the relationship of confining pressure, hydrostatic pressure, and related overburden "weight" is totally misleading. Recharge areas were not mentioned (altitude relationships), and many confined aquifers are not overlain by other aquifers but by very thick sequences of confining materials that contain little or no extractable ground water. I suggest using a referenced definition from a book on hydrogeology to define the pressure relationships between confined versus non-confined aquifers.

60 **47. Page 3-49, second paragraph**--During wetter periods, I doubt that the "saturated zone" was as much as 100 meters higher than it is today because the climatic conditions have nothing to do with tectonism; perhaps a clarification, that the water-table altitude (or another referenced aquifer water level) may be 100 meters higher today than during wetter periods, is needed.

61 **48. Page 3-50, second paragraph**--(*Hydrologic Properties of Rock*) Define hydraulic conductivity, as other parameters are defined.

62 **49. Page 3-51, Table 3-14**--Transmissivity (T) and hydraulic conductivity (K) numbers are not comparable, and of little use, since T values are given in units per day and K values are in units per year. Why make it so difficult to spot check the calculated T values by constantly requiring chronological conversions of the K values? Also, more detail is needed about the calculated T values as shown in the table. On quick inspection, using the given unit thickness (or thickness range) and the given K-value range, the T-value range for the upper volcanic aquifer is 38.6 to 5,671 square meters per day (not 120 to 1,600); for the upper volcanic confining unit the range is 1.8 to 85.9 (not 2.0 to 26); for the lower volcanic aquifer it is <1.4 to 9,014 (not 1.1 to 3,200); and the T-value range for the lower volcanic confining unit is 0.002 to >82.6 square feet per day (not 0.003 to 23). Of course these values need to be "rounded" using significant-figure protocol. The higher end members of the estimated T-value ranges would have a significant impact on the potential movement of contaminants through this hydrogeologic system, so the T values in Table 3-14 need to be substantiated.

63 **50. Page 3-52, second paragraph**--(*Water Source and Movement*) Reference the tectonic event and water-table slope figures. Also, water-table gradients are big, small, huge, tiny, and large, etc; but never "steep" as stated. Again, the potentiometric surface discussion in this paragraph, on the rest of this page, and on page 3-53 would be greatly enhanced by showing a simple potentiometric-surface map. The reader could see the described features instead of trying to figure out where they are located by textual descriptions.

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64 **51. Page 3-53, first paragraph**--Reference age-date values and climatic discussion.

65 **52. Page 3-53, second paragraph**--Again, Fortymile Canyon or Wash? Also, define "substantial" recharge. The connotation is that 3,400 acre-feet of recharge along the course of Fortymile Canyon are "not" substantial, true or not? To most hydrogeologists this amount of recharge, in an arid environment, is indeed substantial.

66 **53. Page 3-53, sixth paragraph**--(*Outflow from Volcanic Aquifers at and Near Yucca Mountain*) Again, a potentiometric-surface map would greatly clarify the discussion of the configuration of the ground-water surface. A lot is left to "faith" in these discussions (are descriptions accurate?). Also, again, page 3-38, Figure 3-13, does not show ground-water movement to and discharge occurring in Death Valley; it is questioned.

67 **54. Page 3-55, Figure 3-17**--Are the legend designations rock types or aquifers (for example, carbonate rock)? If they are rock types, hydrologic and water-quality information collected from relevant wells are not correlative, and thus useless.

68 **55. Page 3-56, Table 3-16**--This is a very difficult table to analyze. What is a median water level? Water levels are usually established as an annual average or more often, measurements are made on given dates and are compared on a year-to-year basis. What was the period of measurement for the study? Was it 1992 through 1997? Is "Average deviation about the median" an annual average fluctuation or a fluctuation from year-to-year on a given date? Also, for "Difference (from the) baseline," are median and baseline equal terms? Water levels measured in production wells (J-12 and J-13) are meaningless.

69 **56. Page 3-57, first paragraph**--The nearness to or distance from Fortymile Canyon (or Wash) has little, if anything, to do with water levels measured in the wells. The key is, in which aquifer is each well completed? According to page 3-56, Table 3-16, the two wells with largest positive variations in water level were JF-2a and J-11. Well JF-2a is completed in carbonate-rock (aquifer) and well J-11 is completed in volcanic-rock (aquifer) (see page 3-55, Figure 3-17), the latter being located some six miles east of the other five wells completed in a north-south line near Fortymile Canyon (which are also completed in volcanic rock). Well JF-2a water levels are obviously not connected to like measurements made in the Fortymile Canyon well array. Well J-11 is located down-dip geologically (see page 3-43, Figure 3-14, for the general geological attitude of units) from the north-south Fortymile Canyon well array, and is probably completed in a differing volcanic aquifer than wells JF-1, JF-2, J-13, J-12, and JF-3. Well-completion data, constructed hydrogeologic cross-sections, and water-quality data would help resolve this issue and more clearly define the hydrgeologic system.

70 **57. Page 3-57, Table 3-17**--Composite water-quality data are presented for 12 volcanic-aquifer wells (footnote b), but page 3-55, Figure 3-17, shows only eight (by my count) wells completed in volcanic rock. Why the discrepancy? Also, are all 12 of these volcanic-aquifer wells completed in the same aquifer? Is there a water-quality variation from the upper-volcanic aquifer to the lower-volcanic aquifer? Correlate tabular water-quality data with well-completion data and show an appropriate location map.

71 **58. Page 3-58, Table 3-18**--Separate the two volcanic aquifers (upper and lower) in the "Contributing aquifer" column, if possible. Also, footnote b reference to Figure 3-18, should be to Figure 3-17.

72 **59. Page 3-58, first paragraph**--(sentence immediately following Table 3-18) Will monitoring for comparisons between the differing contributing aquifers continue throughout the operation of the proposed repository and well into the post-closure period? It would be reassuring, if true.

73 **60. Page 3-61, Figure 3-18**--What does the boundary designation "between two individual vegetation coverages" mean? It is not discussed in the text. Why not use the "analyzed land withdrawal area" as noted on page 3-60, first paragraph? Also, the analyzed area on this figure does not match that on page 1-16, Figure 1-6, which was used for other proposed-repository studies--why not?

74 **61. Page 3-126, 3.2.2.2.3.2 Ground Water, first paragraph**--Ground-water sub-basins and hydrographic areas do "not" equate (see Volume I, comment number 27 in this review, and page 3-38, Figure 3-13).

75 **62. Page 3-128, Table 3-43**--Again, hydrographic areas and ground-water basins do "not" equate (see previous comment).

76 **63. Page 4-28, second paragraph**--Why introduce a water-level-decline value here (12 centimeters) that was not used in the section 3.1.4.2.2, Ground Water at Yucca Mountain discussion? The maximum decrease discussed on page 3-56, Table 3-16, and in related text was 6 centimeters (calculated below the average deviation about the median). Numbers related to water level declines and/or increases should be consistent throughout the DEIS.

77 **64. Page 4-29, second paragraph**--If the estimated water demands for repository development and emplacement activities exceed that for the lowest "regulated" yield for the Jackass Flats hydrographic area (in combination with other Nevada Test Site activities) under the l-t-l scenario, what is the identified source for the additional water?

78 **65. Page 4-99, Figure 4-5**--Where is the location of the waste-retrieval and storage area with reference to Midway Valley? The referenced page 3-34, Figure 3-12, shows the location of Midway Valley (sort of) but the actual location of the waste-retrieval and storage area is still unknown.

79 **66. Page 4-103, second paragraph**--(*Potential for Flooding*) Because the actual location of the waste-retrieval and storage area is unknown (or at least ill defined), whether or not the facility would be affected by a pmf event is not discernable. The approximate location of the waste-retrieval and storage area will have to be plotted on page 3-34, Figure 3-12, (and referenced) before the accuracy of this statement can be ascertained.

80 **67. Page 5-24, Figure 5-3**--The flow-direction arrow in the lower southeast corner of the figure (near and pointing towards the California-Nevada border) is not within the Central Death

Valley (hydrologic) Subregion, as shown on page 3-38, Figure 3-13. Why is it shown and is it important? Also, again, the community of Lathrop Wells is now known as Amargosa Valley.

81 **68. Page 6-55**--(HYDROGRAPHIC AREA blockout) Again, as this definition seems to imply, ground-water basins (or sub-basins) and hydrographic areas do "not" equate. Also, this definition should have come much earlier in this volume, on page 3-39 and/or on page 3-38, Figure 3-13. This would have clarified a few of my preceding comments (see Volume I comment numbers 27, 61, and 62 in this review).

82 **69. Page 8-33, seventh paragraph**--The discussion fails to mention that under the low thermal load waste-emplacement scenario, when combined with other Nevada Test Site ground-water usage, the 580 acre-feet per year yield value will be exceeded (see page 4-29, second paragraph, and Volume I, comment number 64 in this review).

83 **70. Page 8-35, second paragraph**--The statement about 280 acre-feet per year for water use is incorrect. According to page 3-56, Table 3-15, that value represents total water use for 1994 and not for just the Nevada Test Site "ongoing" activities, as the statement implies. How was the 280 acre-feet value determined? Table 3-15 shows that the total use from the Jackass Flats hydrographic area has been as high as 400 acre-feet (for 1996), and only 66 acre-feet of that total were for Yucca Mountain site-characterization activities. Will ongoing activities at Yucca Mountain and the Nevada Test Site decrease to a point where they require much less water?

84 **71. Page 8-35, fifth paragraph**--The 15,000 acre-feet per year reference should be to page 3-40, Table 3-11 (not Table 3-10), and the correct withdrawal amount is 14,000 acre-feet (not 15,000 acre-feet as stated).

85 **72. Page 9-5, second bullet--(Surface-Water Measures Under Consideration)** Using "hay bales" as more-or-less mitigative devices to trap sediment will be a short-term solution at best (by the way, straw is much cheaper). Using fabric fences and longer lasting "weir-notched" dams to create an impoundment for trapping sediment would be more reliable in accomplishing this task.

86 **73. Page 9-12, 9.2.8 LONG-TERM REPOSITORY PERFORMANCE, third paragraph, first bullet-- (Long-Term Performance Measures Under the Proposed Action)** Given that the thickness of the unsaturated zone between the proposed repository horizon and the water table would range from 175 to 365 meters (see page 3-41, fifth paragraph), saying that the thickness is about 300 meters is incorrect. Hopefully the thickness range, and the lesser number in particular, was used in designing the engineered-barrier system.

87 **74. Page 10-2, 10.1.1.3 Hydrology, third paragraph**--Again, using an average unsaturated-zone thickness is inaccurate (see previous comment) when waste-package emplacement and waste-containment discussions should refer to the 175-meter thickness to represent "worst-case" approximations. Also, 300 meters is equated to 980 feet on page 9-12, last paragraph, first bullet, but here it is listed as being equal to 1000 feet. Revise to correct number and be consistent throughout the DEIS.

88 75. **Page 10-2, 10.1.1.3 Hydrology, fourth paragraph**--Again, there is a consistency problem. On page 3-44, last paragraph, 0.65 centimeter is equated to 0.3 inch, but here it equals 0.31 inch. This is a small difference, but they are not the same equalizations. Revise and be consistent.

89 76. **Page 10-3, third paragraph**--Again, the thickness range rather than an incorrect "about" value (see Volume I, comments number 73 and 74 in this review) needs to be used. Potentially, greater amounts of long-lived water-soluble radionuclides could move through 175 meters of the unsaturated zone, as compared to 300 meters, and in a much shorter time frame. These "worst-case" approximations should be considered in determining the viability of using Yucca Mountain as a proposed repository location.

Volume II - Appendixes A through L

90 1. **Page A-34 through Page A-35, A.2.3.2.2 Idaho National Engineering and Environmental Laboratory, first paragraph**--"...treatment as well as alternative terminologies...," I assume, is referring to alternative technologies. If not, please explain.

91 2. **Page I-16, Table I-11**--Footnote references c and d appear to be reversed. "Solubility in repository water by EQ3 simulation" should reference Wolery, 1992, EQ3 code version, Version 7.0; and "EQ6 simulation of Alloy 22 corrosion" should reference Wolery and Daveler, 1992, EQ6 code, Version 7.0. Also, as noted in the References on page I-116, both are listed as code Version 7.0, not Version 7.2b as shown in footnotes c and d. Should additional references for code Version 7.2b be added to the References and referred to here?

92 3. **Pages I-88 through I-96, Figures I-27 through I-35, respectively**--Very few faults are shown on the base maps of these figures and as such, they misrepresent the complex faulted-geologic structure that is representative of the Yucca Mountain area. By looking at these figures one would conclude that not one major, or minor, fault is coincident with the location of a proposed repository block and this simply is not true! An accurate depiction should be shown on all figures (also see Volume I, comment number 8 in this review).

93 4. **Page L-12, Table L-2**--The length of the Valley Modified rail corridor is 159 kilometers, or 99 miles; however, in the Summary, page S-55 blockout, this measurement is given as 98 miles. Again, this is a small difference but the numbers are different. Another example of the need for consistency from section to section, chapter to chapter, and volume to volume to provide clarity and confidence in the DEIS.

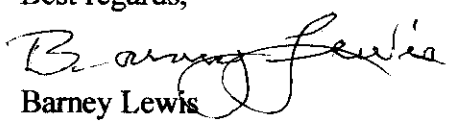
94 In general, I found that "quality control" (qc) within the DEIS was less than desirable. Many times, as noted in the above comments, when numbers were spot checked for consistency from one chapter and/or section to another, many errors were found. A thorough qc check of the entire DEIS
95 should be made and these inconsistencies eliminated. Also during the discussion of geology, hydrogeology, and hydrology in Chapter 3 there is great confusion from one section to another when trying to determine the differences between (or similarities among) designations for, physical

and chemical characteristics of, structural controls on, and areal and sub-surface extents of
17 (cont'd.) discussed units. Given that about 30 pages were omitted from Chapter 3, in the copy of the DEIS
96 that I received, a final qc run-through was needed prior to mailing. On many occasions studies that related to a topical discussion were eluded to but no information was given about these comparative situations. Simple statements about similar or diverse circumstances were mentioned, and no related values were given for comparisons. These statements were seldom, if ever, referenced. Again, these inconsistencies tend to make the overall discussions and supporting material unclear and hence, may result in the reader questioning the scientific/technical validity of the DEIS. Confusing dialog, figures, and tables should be clarified, referenced, and presented consistently when they appear in differing parts of the DEIS.

97 The material presented on radiological issues, socioeconomics, transportation, no-action alternative, and waste management (other than Chapter 3, these were the chapters and sections that I looked at more closely) was done in a concise and informative manner (was easy to read and understand). Of great informational effect were the "blockouts" (side bars, info boxes, or whatever they are called) that supplied definitions, clarified or expanded on textual discussions, and provided examples of discussed studies/topics. Although a couple of these blockouts were ill placed (they could have come earlier in a chapter or volume), I found them very useful and informative. The layout of the Summary was well accomplished and the graphic displays were visually very impressive, making this part of the DEIS a pleasure to read. Table S-1 was of particular interest and it was found to be very informative and easy to use, good stuff!

Please note that to the best of my ability, I've tried to not replicate the comments and/or suggestions' made concerning this DEIS in other U.S. Geological Survey transmittals. Thanks again for the opportunity to review and comment on this DEIS, and for enabling me to revisit Yucca Mountain and the proposed-repository studies. Please contact me if you have questions and/or comments about this write up.

Best regards,



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